Quarterly Progress Report

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Near-Term Objectives

1) Prepare manuscript on phytoplankton fluorescence and primary productivity
2) Deliver next version of chlorophyll fluorescence efficiency code to Miami
3) Present results on bio-optical time scales as estimated from Lagrangian drifters
4) Participate in International Ocean Color Coordinating Group meeting on ocean color calibration and validation
5) Begin chemostat experiments on fluorescence
6) Prepare bio-optical equipment for Hawaii JGOFS mooring
7) Continue development of advanced data system browser
8) Complete tests of high-speed ATM networking to the desktop

Task Progress

1) Southern Ocean Data

Ricardo Letelier and I have completed the first draft of a manuscript on estimating primary productivity from chlorophyll fluorescence. This manuscript will be submitted to *Science*. Using observations of fluorescence from a bio-optical drifter in the Southern Ocean, we were able to estimate the product of the quantum yield of fluorescence and the cross-sectional area of Photosystem II based on the ratio of fluorescence to chlorophyll. Using some simple assumptions regarding absorption cross-section, we were also able to simplify this relationship to determine fluorescence quantum yield alone. These results showed a strong response in quantum yield to upwelling of nutrients within an eddy which had trapped the drifter for forty days. The quantum yield tended to fall into one of two regimes, thus suggesting that a relatively simple model of primary productivity may be developed from MODIS observations of the fluorescence/chlorophyll ratio.

2) Chlorophyll Fluorescence Efficiency

With the delivery of our fluorescence line height code to Miami, we also included an initial code to calculate chlorophyll fluorescence efficiency (CFE). Since then, we

have made significant progress in the theoretical aspects of CFE and we will deliver a new algorithm to Miami in the next month.

3) Lagrangian Time Scales

We presented the results of our analysis of Lagrangian decorrelation scales using bio-optical drifters in the California Current. As expected, the time scales of temperature and chlorophyll were shorter in the more energetic, nearshore upwelling region than in the more quiescent region offshore. The similarity of the temperature and chlorophyll time scales indicates that similar processes are governing the two variables. Unlike previous studies, though, the time scales of the physical processes associated with the temperature patterns became much longer offshore than the processes affecting the chlorophyll patterns. Either the physical regime or the biological community were significantly different than offshore. This result supports the notion that time series of satellite observations may be used to classify ecosystem structure in the upper ocean.

4) Calibration/Validation Activities

I attended the first meeting of the International Ocean Color Coordinating Group (IOCCG) on calibration and validation of satellite ocean color sensors. I presented results from our bio-optical drifter studies, and showed how relatively inexpensive moorings and drifters could be used to study scales not amenable to satellite observations as part of the validation process.

5) Chemostat Experiments

Based on results from the bio-optical drifters and from joint experiments with Dr. Paul Falkowski, Dr. Letelier has begun chemostat experiments with phytoplankton cultures to investigate the physiology associated with changes in fluorescence quantum yield. The objective is to develop a primary productivity algorithm from first principles rather than on simple statistical relationships. We will also be able to quantify the error budget associated with the algorithm

6) Bio-Optical Mooring

We have assembled the components to install a bio-optical sensor at the JGOFS Hawaii Ocean Time-Series station north of Oahu., The deployment of this mooring has been delayed until summer because of funding difficulties encountered by other participants. We have also ordered the components necessary to assemble another bio-optical sensor. The upper sensor will be set at 30 m depth and the second sensor will be at 100 m. Dr. Letelier will also participate in a cruise this summer north of the HOT site to study primary productivity and fluorescence.

7) Data System Browser

We are building an Internet browser based on application programming interfaces developed by Microsoft. This system will allow us to assemble custom data base query and analysis tools using off-the-shelf applets and custom object controls built

under Visual C++ and Java from Sun Microsystems. The advantage of this approach is the high level of code reuse that is possible in this environment. We have completed the first browser to query and analyze our drifter data base. This will be extended to our imagery data base in the next few months.

8) High-Speed Networking

In conjunction with Adaptec, we tested high-speed Asynchronous Transfer Mode (ATM) networking to the desktop. Although the basic technology works well, it does not scale up well to many simultaneous users. The data server (in this case, a SQL data base running Microsoft SQL Server) could not sustain adequate performance beyond about six clients. Thus ATM still requires considerable development before it can be used as a networking protocol to the desktop.

Anticipated Activities

1) Bio-Optical Mooring and Drifters

We will deploy two bio-optical sensors at the Hawaii Ocean Time-Series site for algorithm development and validation. We also plan to deploy three bio-optical drifters at the Polar Front as part of the U.S. JGOFS Southern Ocean study this September. We have been funded by NSF to deploy a high-density array of bio-optical moorings and drifters at the Polar Front, with the bulk of the sensors scheduled for deployment in 1997-1998.

2) Laboratory Work

We will continue chemostat experiments on fluorescence quantum yield and primary productivity.

3) Information Management

We will complete two Web-based browser and data analysis systems for the drifter data base and the satellite imagery data base. Using custom and purchased objects, we will be able to assemble custom environments easily.

4) Software

We will deliver an improved version of the CFE algorithm to Bob Evans at Miami.

Problems/Corrective Actions

The saga of the Fast Repetition Rate Fluorometer continues. The patent for the FRR has been transferred to Chelsea instruments, and we are in the queue to receive an instrument next year. However, we should be able to borrow an FRR for some of our field work off Hawaii this summer. Lastly, the irregular funding supply has made it difficult to plan equipment acquisitions in an orderly manner.